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City of Los Angeles
Information Technology Agency
200 North Main Street, Room 1400
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Attention: Office of Bob Blumenfield, City Council Member
200 N. Spring St. #415
Los Angeles, CA 90012

Cc: City Clerk, for Los Angeles City Council File 13-0953

Re: CityLinkLA Project

April 22, 2016

Dear Information Technology Agency, City Council and Innovation, Grants, Technology, Commerce, and Trade Committee:

I have been asked to comment on the health and safety of the proposed citywide Wi-Fi CityLinkLA program. I am happy to do so. Because this is a long document, I want to first outline what is in this document so you can see how it all fits together:

1. FCC and other safety guidelines are based on the assumption that microwave frequency electromagnetic fields (EMFs) can only produce thermal (heating) effects. In other words they claim that there cannot be any non-thermal effects on our bodies.
2. However there have been many thousands of studies in the scientific literature, published from the 1950's to the present, with each of these showing the existence of one of more non-thermal EMF effects.
3. There is a consensus among independent scientists, as shown by the 2015 Appeal to the United Nations signed by 220 independent research active scientist experts in this area, that there are non-

thermal health effects produced by these EMFs and that the current safety guidelines are inadequate because they do not take these non-thermal effects into consideration.

4. I have listed 11 different health effects of such non-thermal exposures, several of which have been found to be produced by Wi-Fi exposure. When one looks at these health impacts it is clear that non-thermal EMF exposures attack: our health; our brain function; the integrity of our genomes; and our ability to produce healthy offspring.
5. Neither Wi-Fi apparatuses nor other devices putting out such EMFs are ever tested biologically for safety – not even one of them, not even once. Such biological safety testing is the only way to say anything about their biological impacts. All assurances of safety that you will see in industry propaganda, are based on a theory that has been shown to be false and should have been discarded, in my opinion, over 40 years ago.
6. I have found what appears to be the main mechanism of action of these by which low-intensity EMFs produce these non-thermal effects. This mechanism which is described below, is that these EMFs activate what are called voltage-gated calcium channels. Most if not all of the effects produced (see #4 above) can be understood as being caused by the excessive calcium levels in the cell produced through this activation.
7. In Table 1, I present 16 studies of health-related impacts of Wi-Fi exposure, each of which have found one or more health related impacts of Wi-Fi. 5 of these health effects have been replicated in these Wi-Fi studies; these 5 have also been found to occur repeatedly in other low-intensity EMF studies and should, therefore be considered established effects of Wi-Fi. Industry propaganda claims that Wi-Fi has no health effects should be rejected out of hand.
8. There are some "Wi-Fi" studies that have been claimed by industry to have found no effects. These studies are tiny studies that have no statistical power to make any such claim and they are also studies where the effects of simulated Wi-Fi were studied not real Wi-Fi.
9. There are four different types of studies, each of which provide evidence for cumulative effects of non-thermal EMF exposures. While none of these looked at Wi-Fi, they suggest that it is likely that biological impacts of Wi-Fi will get much worse over time and therefore the short term studies described in #7 may only describe

a small part of the long-term effects.

The FCC guidelines as are many other such guidelines, are based on the assumption that only heating effects of microwave/lower frequency EMFs can have biological effects. However that assumption has been falsified by thousands of studies published from the 1950s to the present, each showing that non-thermal levels of exposure often produce biological effects. For example, in 1971, the U.S. Office of Naval Medical Research produced a document reporting over 100 different non-thermal effects [1], listing 40 apparent neuropsychiatric changes produced by non-thermal microwave frequency exposures, including 5 central/peripheral nervous system (NS) changes, 9 central NS effects, 4 autonomic system effects, 17 psychological disorders, 4 behavioral changes and 2 misc. effects [1]. It also listed cardiac effects including ECG changes and cardiac necrosis as well as both hypotension and hypertension, and also 8 different endocrine effects. Changes affecting fertility included tubular degeneration in the testis, decreased spermatogenesis, altered sex ratio, altered menstrual activity, altered fetal development, programmed cell death (what is now known as apoptosis) and decreased lactation. Many other non-thermal changes were also listed for a total of over 100 non-thermal effects. They also provided [1] over 1000 citations documenting these various health effects. That was almost 45 years ago and is only the beginning of the evidence for the existence of non-thermal effects. My own recent paper [2] shows that widespread neuropsychiatric effects are caused by non-thermal exposures to many different microwave frequency electromagnetic fields (EMFs).

Tolgskaya and Gordon [3] in 1973 published a long and detailed review of effects of microwave and lower frequency EMFs on experimental animals, mostly rodents. They report that non-thermal exposures impact many tissues, with the nervous system being the most sensitive organ in the body, based on histological studies, followed by the heart and the testis. They also report effects of non-thermal exposures on liver, kidney, endocrine and many other organs. The nervous system effects are very extensive and include changes many changes in cell structure, dysfunction of synaptic connections between neurons and programmed cell death and are discussed in Refs. [2,3] and more modern studies reporting extensive effects of such non-thermal EMF exposures on the brain are also cited in [2]. There are also many modern studies showing effects of non-thermal exposures on fertility in animals.

The Raines 1981 National Aeronautics and Space Administration (NASA) report [4] reviewed an extensive literature based on occupational exposures to non-thermal microwave EMFs. Based on multiple studies, Raines [4] reports that 19 neuropsychiatric effects are associated with occupational microwave/ radiofrequency EMFs, as well as cardiac effects, endocrine including neuroendocrine effects and several other effects.

I reviewed many other scientific reviews on this topic, each of which clearly supports the view that there are various non-thermal health impacts of these EMFs [5]. In 2015, 220 international scientists signed a statement sent to the United Nations Secretary General and to member states, stating that international safety guidelines and standards are inadequate to protect human health [6]. Each of these 220 scientists from 41 countries had scientific publications on biological effects of such EMFs for a total of over 2000 peer reviewed publications; therefore each is well qualified to judge this. **It can be seen from this statement to the UN, that there is a strong scientific consensus that current safety guidelines and standards are inadequate because they do not take into consideration any of the non-thermal health effects produced by various EMF exposures. That scientific consensus also rejects, therefore, the FCC EMF guidelines, guidelines that cannot be defended.**

It can be seen from the previous paragraphs, that the following non-thermal effects of EMF exposures are well documented:

- Widespread neuropsychiatric effects
- Several types of endocrine (that is hormonal) effects
- Cardiac effects impacting the electrocardiogram (Note: these are often associated with occurrence of sudden cardiac death)
- Male infertility

However, there are many additional types of biological changes produced by non-thermal EMF exposures (reviewed in 5,7] including:

- Oxidative stress
- Changes in calcium fluxes and calcium signaling
- Several types of DNA damage to the cells of the body, including single strand and double strand DNA breaks and 8-OH-guanine in DNA
- Cancer (which is undoubtedly caused, in part, by such DNA damage)
- Female infertility

- Lowered melatonin; sleep disruption
- Therapeutic effects of EMFs when they are highly controlled and focused on a specific part of the body

It can be seen from the above, that each of the things that we most value as individuals and as a species are being attacked by non-thermal microwave frequency EMFs [5.7]:

- **Our Health**
- **Our brain function**
- **The integrity of our genomes**
- **Our ability to produce healthy offspring**

I want to emphasize that the specific health effects listed above are **not** the only things that are likely to be impacted by non-thermal EMF exposures, they are however the best documented such effects.

While it has been clear for many years that there are many non-thermal health effects of microwave frequency EMFs, it has not been clear until about 2 ½ years ago, how these effects are produced by such exposures. I found evidence for this mechanism in the scientific literature in 2012 and published on it in mid-2013. This 2013 paper [8] was honored by being placed on the Global Medical Discovery web site as one of the most important medical papers of 2013. At this writing, it has been cited 77 times according to the Google Scholar database, with over 2/3rds of those citations occurring over the past year. So clearly it is having a substantial and rapidly increasing impact on the scientific literature. I have given 26 professional talks, in part or in whole on EMF effects in 10 different countries over the last 2 1/2 years. So it is clear that there has been a tremendous amount of interest in this research.

What the 2013 study showed [8], was that in 24 different studies (and there are now 2 more that can now be added [2,7]), effects of low-intensity EMFs, both microwave frequency and lower frequency EMFs could be blocked by calcium channel blockers, drugs that block what are called voltage-gated calcium channels (VGCCs). There were a total of 5 different types of calcium channel blocker drugs used in these studies, with each type acting on a different site on the VGCCs and each thought to be highly specific for blocking VGCCs. What these studies tell us is that these EMFs act to produce non-thermal effects by activating the VGCCs. Where several effects were studied, when one of them was blocked or greatly lowered, each other effect studied was also blocked or greatly lowered. This tells us that the role of VGCC activation is quite wide – many

effects go through that mechanism, possibly even all non-thermal effects in mammals. There are a number of other types of evidence confirming this mechanism of action of microwave frequency EMFs [2]. Each of the 11 health impacts caused by non-thermal EMF exposures can be explained as being produced by indirect effects of VGCC activation [5,7].

It is now apparent [7] that these EMFs act directly on the voltage sensor of the VGCCs, the part of the VGCC protein that detects electrical changes and can open the channel in response to electrical changes. The voltage sensor (and this is shown on pp. 102-104 in [7]) is predicted, because of its structure and its location in the plasma membrane of the cell, to be extraordinarily sensitive to electrical forces produced by these EMFs, about 7.2 million times more sensitive than are single charged groups elsewhere in the cell. What this means is that arguments that EMFs produced by particular devices are too weak to produce biological effects, are immediately highly suspect because the actual target, the voltage sensor of the VGCCs is extremely sensitive to these EMFs. **Because heating is mostly produced by forces on these singly charged groups elsewhere in the cell, limiting safety guidelines to heating effects means that these guideline allow exposures that are something like 7.2 million times too high.**

Why then does the FCC stick with these totally unscientific safety guidelines? That is the 64 billion dollar question. The FCC has been shown, in a long detailed document published by Harvard University Center for Ethics, to be a "captured agency", that is captured by the telecommunications industry that the FCC is supposed to be regulating [9; can be obtained full text from web site listed in 9]. So perhaps the failure of the FCC to follow the extensive science in this important area, can be understood. Of course, what that means is that the FCC is completely failing in its role of protecting the public and it is a major blunder, therefore for either you or any other organization to depend on the FCC guidelines as a reliable predictor of impacts of EMFs in humans.

So what is known about health impacts of Wi-Fi EMFs?

Table 1. The following Table summarizes various health impacts of Wi-Fi EMF exposures:

Citation(s)	**Health Effects**
[10,11,12,13,14,15,1	Sperm/testicular damage, male infertility

6]	
[10,15,17,18,19,20]	Oxidative stress
[20]	Calcium overload
[11,12,20]	Apoptosis (programmed cell death)
[17]	Melatonin lowering; sleep disruption
[10,13]	Cellular DNA damage
[21]	MicroRNA expression (brain)
[18]	Disrupts development of teeth
[22]	Cardiac changes, blood pressure disruption; erythrocyte damage; catecholamine elevation
[23,24]	Neuropsych changes including EEG
[25]	Growth stimulation of adipose stem cells (role in obesity?)

Each of the effects reported above in 2 to 7 studies have an extensive literature for their occurring in response to various other non-thermal microwave frequency EMFs so it should be clear that these observations on Wi-Fi exposures are highly probable to be correct. These include (see Table 1) findings that Wi-Fi exposures produce impacts on the testis leading to lowered male fertility; oxidative stress; apoptosis (a process that has an important causal role in neurodegenerative diseases); cellular DNA damage; neuropsychiatric changes including EEG changes. Each of these are very serious: Oxidative stress has causal roles in many different human diseases; cellular DNA damage can cause cancer and produce mutations that impact future generations (if there are any; see below [26]); apoptosis has central roles in neurodegenerative diseases; The neuropsychiatric effects are almost certainly caused by the impacts of EMFs on brain structure which are, in my opinion, horrendous. We are, of course seeing major lowering of sperm counts and sperm quality in many countries around the world; given the major impact of EMF exposures on sperm count and quality in both human and animal studies, the pattern of evidence is very worrying.

One issue that has been raised about the effects of these low-intensity EMFs producing biological effects is are they cumulative? I am aware of 4 different types of evidence for cumulative effects, over different time periods. Three of the human occupational exposure studies from the 1970s reviewed in [4], showed that effects increased substantially with increasing time of exposure to a particular type and intensity of EMF.

The impacts of such EMFs on animal brains (reviewed in [3] and discussed

in [2]), initially over periods of 1 to 2 months showed relatively modest changes in structure of the brains and the neurons and when exposures ceased, most of the structural changes disappeared – that is the changes were reversible. However more months of exposure produced much more severe impacts on brain and neuronal structure and these were irreversible.

Studies of headaches during or immediately after cell phone usage showed the following: Headaches usually only occurred after calls of over one hour in duration and when they occurred, the headache was on the side of the head where the cell phone was held. The headache studies also suggest cumulative effects, in this case over periods of over one hour.

Finally Magras and Xenos [26] put pairs of young mice into cages on the ground at two locations each with two somewhat different exposures within an antenna park. The exposure levels at both sites were well within safety guidelines, so if the safety guidelines have any biological relevance, there should be no effects. It takes about one month for mice to go through gestation. At the higher level exposure, the pairs produced one litter of approximately normal size, and a second litter with lowered numbers of progeny; after that they were completely sterile. At the other site, the mating pairs produced four litters, with decreasing numbers of progeny over time followed by complete sterility. It should be noted that [15] shows that Wi-Fi exposure can impact animal reproduction.

It can be seen from these four examples that each shows evidence for cumulative effects over somewhat different time periods. One thing that should tell us is that the short-term Wi-Fi studies shown in Table 1 may greatly underestimate the damage Wi-Fi may do over much longer time periods.

Summary:

1. 15 studies have each shown health effects of Wi-Fi, most of which have also been shown to occur in response to low intensity exposures to other types of microwave frequency EMFs, These are likely to have massive health effects by producing male infertility (female infertility has not been studied in response to Wi-Fi), oxidative stress (involved in dozens of human diseases), cellular DNA damage (possibly leading to both cancer and mutations in future generations), life threatening cardiac effects, cellular apoptosis and also intracellular Calcium overload (with both of these

possibly leading to neurodegenerative diseases), various neuropsychiatric changes and many others.

2. The FCC has been shown, in a detailed Harvard's University report, to be a Captured Agency, captured by the industry that it is supposed to be regulating. This provides an additional reason to be very highly skeptical about all FCC safety guidelines.
3. The EMF safety guidelines supported by the FCC and others assume that only heating need be of concern. These assumptions have been known to be false for at least 45 years and there is a scientific consensus on this, that has lead to the petition by 220 highly qualified international scientists to the UN stating that current safety guidelines are inadequate.
4. The voltage sensor of the VGCCs is stunningly sensitive to such low intensity EMFs, about 7.2 million times more sensitive than are singly charged groups everywhere in our cells. The consequence of this is that safety guidelines allow exposures that are roughly 7.2 million times too high.
5. We know now that low intensity non-thermal exposures work via VGCC activation and that indirect effects of such VGCC activations can produce each of the health effects that have been widely reported to occur in response to such EMF exposures for something like 60 years. Low intensity EMFs attack:
    a. **Our health**
    b. **Our brain function**
    c. **The integrity of our genomes**
    d. **Our ability to produce healthy offspring**

I am greatly concerned about the proposed Wi-Fi CityLinkLA program. I have no doubt that you have been given much industry propaganda claiming safety to the Wi-Fi to be used for this program. Much of the propaganda I have seen is either carefully worded misleading "information" or complete falsehoods. *None of these devices is ever tested biologically for safety which is the only way to even approach any safety issue.* It is my opinion that going ahead with the Wi-Fi CityLinkLA program would be a blunder of historic proportions. The research attached and cited shows that, at the power levels and pulsations required for Wi-Fi to operate reliably over the project's large areas, the Microwave Frequency Radiation will have substantial and probably cumulative biological health effects, especially on children, pregnant women and individuals who may be particularly sensitive for genetic or other reasons. Please contact me if I can provide further information or help on

this issue.

Martin L. Pall, Professor Emeritus of Bioichemistry and Basic Medical Sciences, Washington State University (see contact information at the beginning of this document).

Literature cited:

[1] Naval Medical Research Institute Research Report, June 1971. Bibliography of Reported Biological Phenomena ("Effects") and Clinical Manifestations Attributed to Microwave and Radio-Frequency Radiation. Report No. 2 Revised.
[2] Pall ML. 2015. Microwave frequency electromagnetic fields (EMFs) produce widespread neuropsychiatric effects including depression. J. Chem. Neuroanat. 2015 Aug 20. pii: S0891-0618(15)00059-9.doi: 10.1016/j.jchemneu.2015.08.001. [Epub ahead of print] Review.
[3] Tolgskaya MS, Gordon ZV. 1973. Pathological Effects of Radio Waves, Translated from Russian by B Haigh. Consultants Bureau, New York/London, 146 pages.
[4] Raines JK. 1981. Electromagnetic Field Interactions with the Human Body: Observed Effects and Theories. Greenbelt, Maryland: National Aeronautics and Space Administration 1981; 116 p.
[5] Pall ML. 2015. How to approach the challenge of minimizing non-thermal health effects of microwave radiation from electrical devices. Int J Innovative Research Engineering Management (IJIREM) ISSN: 2350-0557, Volume-2, Issue -5, September 2015; 71-76.
[6] https://emfscientist.org/index.php/emf-scientist-appeal
[7] Pall ML. 2015 Scientific evidence contradicts findings and assumptions of Canadian Safety Panel 6: microwaves act through voltage-gated calcium channel activation to induce biological impacts at non-thermal levels, supporting a paradigm shift for microwave/lower frequency electromagnetic field action. Rev Environ Health 30:99-116.
[8] Pall ML. 2013 Electromagnetic fields act via activation of voltage-gated calcium channels to produce beneficial or adverse effects. J Cell Mol Med 17:958-65.

[9] Alster N. 2015 Captured Agency: How the Federal Communications Commission Is Dominated by the Industries It Presumably Regulates. Edmond J. Safra Center for Ethics Harvard University 124 Mount Auburn Street, Suite 520N Cambridge, MA 02138 USA http://www.ethics.harvard.edu/http://www.ethics.harvard.edu/files/center-for-ethics/files/capturedagency_alster.pdf
[10] Atasoy HI, Gunal MY, Atasoy P, Elgund S, Bugdayci G. 2013 Immunopathologic demonstration of deleterious effects on growing rat testes of radiofrequency waves emitted from conventional Wi-Fi devices. J Pediatr Urol 9:223-229.
[11] Shokri S, Soltani A, Kazemi M, Sardari D, Mofrad FB. 2015 Effects of Wi-Fi (2.45 GHz) exposure on apopotosis, sperm parameters and testicular histomorphology in rats: a time course study. Cell J 17:322-31.
[12] Dasdag S, Tas M, Akdag MZ, Yegin K. 2015 Effect of long-term exposure of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on testes functions. Electromagn Biol Med 34:37-42.
[13] Avendaño C, Mata A, Sanchez Sarmiento CA, Doncel GF. 2012 Use of laptop computers connected to the internet through Wi-Fi decreases human sperm motility and increases sperm DNA fragmentation. Fertil Steril 97:39-45.
[14] Yildiring ME, Kaynar M, Badem H, Cavis M, Karatus OF, Cimentepe E. 2015 What is harmful for male fertility: Cell phone or wireless internet? Kaosiung J Med Sci 31:480-4.
[15] Özorak A1, Nazıroğlu M, Çelik Ö, Yüksel M, Özçelik D, Özkaya MO, Çetin H, Kahya MC, Kose SA. 2013 Wi-Fi (2.45 GHz)- and mobile phone (900 and 1800 MHz)-induced risks on oxidative stress and elements in kidney and testis of rats during pregnancy and the development of offspring. Biol Trace Elem Res 156:221-9.
[16] Oni OM, Amuda DB, Gilbert CE. 2011 Effects of radiofrequency radiation from WiFi devices on human ejaculated sperm. Int J Res Reve Appl Sci 9: Article 13; 2011.
[17] Aynali G, Nazıroğlu M, Çelik Ö, Doğan M, Yarıktaş M, Yasan H. 2013 Modulation of wireless (2.45 GHz)-induced oxidative toxicity in laryngotracheal mucosa of rat by melatonin. Eur Arch Otorhinolaryngol 2013;270:1695-700.
[18] Çiftçi ZZ, Kırzıoğlu Z, Nazıroğlu M, Özmen Ö. 2015 Effects of prenatal and postnatal exposure of Wi-Fi on development of teeth and changes in teeth element concentration in rats. [corrected]. Biol Trace Elem Res 163:193-201
[19] Tök L, Nazıroğlu M1, Doğan S, Kahya MC, Tök O. 2014 Effects of melatonin on Wi-Fi-induced oxidative stress in lens of rats. Indian J

Ophthalmol 62:12-5.
[20] Çiğ B, Nazıroğlu M. 2015 Investigation of the effects of distance from sources on apoptosis, oxidative stress and cytosolic calcium accumulation via TRPV1 channels induced by mobile phones and Wi-Fi in breast cancer cells. Biochim Biophys Acta 1848(10 Pt B):2756-65.
[21] Dasdag S, Akdag MZ, Erdal ME, Ay O, Ay ME, Yilmaz SG, Tasdelen B, Yegin K. 2015 Effects of 2.3 GHz radiofrequency radiation emitted from Wi-Fi equipment on microRNA expression in brain tissue. Int J Radiat Biol 91:555-61.
[22] Saili L, Hanini A, Smirani C, Azzouz I, Azzouz A, Sakly M, Abdelmelek H, Bouslama Z. 2015 Effects of acute WiFi signals (2.45 GHz) on heart variability and blood pressure in albino rabbits. Environ Toxicol Pharmacol 40:600-5.
[23] Papageorgiou CC, Hountala CD, Maganioti AE, Kiprianou MA, Rabavilas ASD, Papademitriou GN, Capalis CN. 2011 Effects of Wi-Fi signals on the P300 component or event-related potentials during an auditory hayling task. J Integr Neurosci 10:189-202.
[24] Maganioti AE, Papageorgiou CC, Hountala CD, Kiprianou MA, Rabavilas AD, Papademitriou GN, Capalis CN 2010 Wi-Fi electromagnetic fields exert gender related alterations on EEG. 6th International Workshop on Biological Effects of Electromagnetic Fields.
https://www.researchgate.net/profile/Miltiades_Kyprianou3/publication/267816859_WI-FI_ELECTROMAGNETIC_FIELDS_EXERT_GENDER_RELATED_ALTERATIONS_ON_EEG/links/550ab8670cf265693ced8e9c.pdf
[25] Lee SS, Kim HR, Kim MS, Park SH, Kim DW. 2014 Influence of smart phone Wi-Fi signals on adipose-derived stem cells. Ja J Cranofac Surg 25:1902-1907.
[26] Magras IN, Xenos TD. 1997 RF radiation-induced changes in the prenatal development of mice. Bioelectromagnetics 18:455-461.